

BELLCOMM, INC.

SUBJECT: Trip Report - NASA/GAEC Certification
Review Board Meeting, July 19-23,
1965, Bethpage, New York - Case 130
General Mission #3

DATE: August 4, 1965

FROM: T. A. Bottomley

ABSTRACT

The purpose of this meeting was to review the status of the LEM Certification Test Program as it relates to the qualification of hardware for the LEM #1 and the design reference mission.

Based on the review it was determined that:

1. Most LEM subsystems will not complete Qualification Testing by November 15, 1966 - the scheduled date for shipment of the LEM #1 to KSC.
2. Discrepancies exist between GAEC and MSC environmental test requirements which must be resolved.
3. GAEC is developing vehicle test plans but cannot now forecast their date of publication.

While additional test facilities and instrumentation would be helpful in accelerating the LEM Test Program, it appears more economical to reexamine the current test logic to determine whether certain tests could be eliminated as redundant or not critical to overall system performance and whether more hardware might be qualified by analysis.



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BELLCOMM, INC.

SUBJECT: Trip Report - NASA/GAEC Certification Review Board Meeting, July 19-23, 1965, Bethpage, New York - Case 130 **DATE:** August 4, 1965
FROM: T. A. Bottomley

MEMORANDUM FOR FILE

This report covers the writer's attendance at the NASA (MSC)/GAEC Certification Review Board Meeting at Bethpage, New York on July 21 and 22, 1965.

The review board was chaired by Mr. C. H. Perrine (NASA-MSC/SE) and was composed of a daily fluctuating membership selected from the list of attendees shown in Attachment 1. Mr. E. F. Mollenberg, NASA Headquarters, MAT, also attended as an observer.

The stated purpose of the meeting was to review the status of the LEM Certification Test Program as related to the qualification of hardware for LEM #1 and the design reference mission.

Specific objectives of the meeting, as proposed by MSC, were as follows:

1. Establish documentation baselines for (a) test requirements and (b) scheduling of major ground tests.
2. Establish sources which permit deviations from the baselines.
3. Establish a method for tracking and updating the status of all tests.

The suggested documentation and status reporting for certification control are summarized in Attachment 2 of this report.

On the first day, July 19th, the MSC and GAEC Review Board held a general session to establish an approach plan for the LEM Test Program Review. The plan was implemented as follows:

1. A working group, composed of MSC and GAEC technical specialists, was established for each major LEM subsystem.

2. A schedule was prepared which listed the responsible members and established a time for each working group to meet the Review Board (Attachment 3).
3. Each group was requested to examine the test program for their subsystem as it related to:
 - a. Completion of qualification at the system (vehicle) level by 11/15/66 for LEM #1.
 - b. Examination of the test logic based on the ground rules specified in LAV-10-25 and the following guidelines:
 - (1) Design Verification Testing (DVT) shall be completed prior to Qualification Testing.
 - (2) Qualification Testing shall be performed on production (flight-type) hardware and shall be completed prior to shipment of the LEM #1 vehicle.
 - (3) Final Qualification shall be accomplished after vehicle stacking is completed and at least six weeks prior to launch.
 - (4) Unique environments (salt spray, sand, dust, and fungus) testing shall be accomplished last during Qualification Testing. (MSC's current position is that unique environments testing should be accomplished in the same sequence as would be experienced in the course of a mission.)
 - (5) Overstress testing (test to failure), where required, will be accomplished after Qualification Testing is completed.
4. Each working group was provided with a list of "Standard Questions" (Attachment 4) designed to insure that problem areas relating to methods of qualification, test environments, schedule objectives, and status reporting would be uncovered.
5. Based on the results of each subsystem's group analysis and subsequent discussions with the Review Board, action items were generated to resolve problem areas or produce recommendations for their resolution where approval by higher authority was deemed necessary.

The deletion of LTA 4 and the ascent stage of LTA 5 from the LEM Test Program was not considered by the various subsystem managers. The question of satisfying the test objectives formerly assigned to these structures was not addressed.

As defined in the minutes of the July 20, 1965, meeting of the review board "Certification constitutes that portion of the (test) program required to certify flight readiness, which is performed on production hardware and which is not duplicated at a later date; analysis required for certification to be included." This definition includes qualification at the equipment level and higher levels of testing (i.e. subsystem, ground testing and flight testing at the vehicle level).

For most subsystems, only two samples are subjected to testing based on the following program qualification guideline; "The minimum qualification will include one set of equipment subjected to sequential, singly applied environments at design limit conditions, and another set subjected to one operational cycle and one subsequent mission cycle at nominal mission conditions."*

Design Verification Testing (to be accomplished prior to qualification) consists essentially of component, component assembly, and subsystem assembly endurance testing through one mission simulation at environmental levels below those required for qualification.

MSC review board members questioned the desirability of continuing DVT on each subsystem once Qualification Testing is started and Qualification Testing once hardware is committed to installation. In other words, a test phase would be terminated - even though not completed - as soon as a new phase, normally subsequent, is started. GAEC members of the review board were in favor of completing each phase of the testing program even though overlap occurred. The divergent opinions were argued periodically but were not resolved at this meeting.

*Par. 3.6.1 of Enclosure (1) to LAV-10-25 dated May 20, 1965.

Based on the subsystem reviews conducted from July 20th through the 22nd, the following conclusions were reached:

1. Schedules

Examination of test schedules developed on the basis of the guidelines discussed above established the fact that the majority of LEM subsystems will not complete Qualification Testing by 11/15/66. Rendezvous and Landing Radar, Instrumentation and Communications are expected to meet or better the 11/15/66 qualification completion date. The subsystems having the greatest overrun are the ECS (9 weeks) and Propulsion (undetermined). The overrun problem might be resolved for most systems if parallel, rather than serial, testing were incorporated in the schedules. However, this would require dedication of additional units to testing in some instances, and provision of additional test facilities and instrumentation, generally by subcontracting tests to other firms or agencies.

2. Environments

The environmental test requirements established by MSC and GAEC are not consistent in several respects. In a number of instances the test environments differed in level (notably, temperature and vibration). Also, GAEC test plans contained deviations in that certain environments specified by MSC were not incorporated. An action item has been generated to eliminate the inconsistencies.

Much of the discussion relating to test environments is summarized in the following comments:

- a. Most subsystem managers (MSC and GAEC) voiced objections to the unique environments testing (salt, sand, dust, fungus) as unnecessary or too rigorous.
- b. The electronic subsystems managers generally agreed that it was essential to perform full-scale EMI testing with mated LEM and CSM to establish reasonable confidence that EMI could be adequately controlled. The only EMI testing authorized by MSC is that which can be accomplished in conjunction with thermal vacuum testing.
- c. GAEC subsystem managers have given little thought to the effects of hard radiation on their equipment based on the assumption that the crew is the most critical subsystem and sets the permissible limits. MSC and GAEC agreed to explore the requirement for analysis on testing for hard radiation effects.

3. Documentation

GAEC has not published detailed vehicle test plans covering the LEM subsystems but advise that several are in preparation. No attempt was made to establish a due date for completion of these documents at this meeting.

CONCLUSIONS

Current test logic for the LEM Test Program requires that Qualification Testing be accomplished on production (flight-type) hardware. Therefore Qualification Testing cannot be started until the design is frozen for production. The small number of test samples, the extensiveness of the test program (i.e., the variety of environments and periods of endurance testing which range from 700 hours to 1000 hours), and the requirement that testing be accomplished sequentially results in Qualification Testing overrunning the LEM #1 delivery date.

Completion of Qualification Testing requirements at the subsystem level subsequent to qualification at the vehicle level complicates making necessary fixes to installed subsystems which fail to qualify. If qualification is not completed prior to flight, any demonstration of subsystem reliability will necessarily be accomplished at a lower level of confidence.

In order to improve the current LEM Test Program Schedules with an acceptable degree of confidence, consideration might be given to an analysis of test logic to determine if (a) pre-qualification tests can be used for certification of non-critical components, (b) off-the-shelf critical components having adequate test histories can be qualified by analysis, (c) Qualification Testing can be limited to certain component assemblies and to those test environments which are deemed critical to performance; and (d) tests run on prototypes of production hardware can be used to qualify production hardware where the prototype has passed endurance tests while exposed to environments equivalent to those specified for qualification.

Minutes of the LEM Certification Review Board Meeting covering the action items and recommendations agreed to by the board will be published in the next two weeks. The writer has requested that he be added to the distribution list and will distribute copies to be appended to this report upon receipt.


T. A. Bottomley

2031-TAB-eas

Attachments

List of attendees

Proposed Certification Test Control Summary

Subsystem Working Group Schedule

Standard CTP S/S Questions

Copy to

Messrs. E. F. Mollenberg - NASA/MAT
A. F. Phillips - NASA/MAT
M. Savage - NASA/MAT

C. Bidgood
B. F. Brown
J. A. Hornbeck
B. T. Howard
M. W. Hunter II
T. J. McEntee
J. Z. Menard
C. R. Moster
I. D. Nehama
I. M. Ross
W. Strack
T. H. Thompson
G. B. Trousoff
R. L. Wagner

All Members of Department 2031
Department 1023
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ATTENDEES:

NASA

C. H. Perrine - MSC-SE
C. E. McCollough, Jr. - MSC/ASPO
P. E. Fitzgerald - MSC/ASPO
Owen Morris - NASA/RQ&A
C. L. Richardson - NASA/RQ&A
J. R. Arnett - NASA/RQ&A (GE)
R. E. Smylie - NASA/MSC
W. J. Gaylor - NASA/RASPO

GAEC

A. B. Whitaker
D. F. Gebhard
R. Plunkett
J. Gerardi
M. Darnowsky
D. Schmall

PROPOSED CERTIFICATION TEST CONTROL SUMMARY

TEST LEVEL	BASELINE	CERTIFICATION TESTS	STATUS
EQUIPMENT	(1) Major and Minor Equipment Procurement Specification Boiler Plate, 9 January 1965 (2) Enclosure (1) to LAV-10-25* (3) Module Development Test Plan	(Departures from Baseline) (1) Subsystem Development Test Plans (contains special section on certification tests monitored by PERT) (2) Subsystem Design Control Specifications	QSL
SUBSYSTEM	(1) LSP-470-1A, Contract Technical Specification for LEM (2) LSP-470-2A, Master End-Item Specification (3) LED-520-1D (LEM Environmental conditions) (4) Module Development Test Plan (5) Higher Level of Assembly Test Ground Rules (Informal rough draft from MSC)	(1) Subsystem Development Test Plans (contains special section on certification tests monitored by PERT)	PERT

*Transmitted C. McCollough, Jr.
10 June 1965

PROPOSED CERTIFICATION TEST CONTROL SUMMARY

TEST LEVEL	BASELINE	CERTIFICATION TESTS	STATUS
VEHICLE LEVEL	(1) LSP-470-1A, Contract Technical Specification for LEM (2) LSP-470-2A, Master End-Item Specification (3) LED 520-1D (LEM environmental conditions) (4) Module Development Test Plan (5) Higher Level of Assembly Test Ground Rules (Informal rough draft copy from MSC)	(1) Vehicle Test Plans (2) Vehicle Test Procedures (3) Vehicle End-Item Specifications (based on LSP-470-2A) (4) LEM Flight Test Plans (5) End-Item Ground Operations Requirements Plan	PERT

SUBSYSTEM WORKING GROUP SCHEDULE

<u>GROUP NO.</u>	<u>SUBSYSTEM</u>	<u>NASA CO-CHAIRMAN</u>	<u>GAEC CO-CHAIRMAN</u>	<u>BOARD REVIEW DATE</u>
A-1	Crew Provisions	Smylie	Rigsby	7/20
A-2	ECS	Mayo	McClourhan	7/20
A-3	Structures	Langford	Paulsrud	7/20
A-4	Landing Gear	McMullin	Sturiale	7/20
B-1	Stabilization and Control	Shelton	Tsontaris	7/21
B-2	Abort Guidance	Kurten	Bolton	7/21
B-3	Navigation and Guidance	Lewis	Mathis	7/21
B-4	Rendezvous and Landing Radar	Fenner	Greene	7/21
C-1	Displays and Controls	Creech/Franklin	Smith	7/22
C-2	OPER and R&D Instrumentation	Walter/Bills	Gaylo	7/22
C-3	Communications and TV	Irvin	Griffin	7/22
C-4	Electrical Power	Campos	Maiorana	7/22
D-1	Ascent Propulsion	Madyoa	Thompson	7/23
D-2	Descent Propulsion	Lambert	Dandridge	7/23
D-3	Reaction Control	Karakulko	Williams	7/23
D-4	Ordnance Devices	Simmons	Munro	7/23

STANDARD CTP S/S QUESTIONS

Although two samples are being subjected to test and the proper nomenclature of design limit and endurance test is applied, the actual applied testing is somewhat different. In some cases, the samples are subjected to different environmental and/or performance tests without any one sample being subjected to all such required tests.

1. Are all your design requirements verified by the presently planned certification program?
2. Does sum of parts on which certification tests were identified equal the whole S/S? Is there "type certification"?
3. Are the qual environments consistent with that published by MSC?
4. Is qual complete prior to LEM pack and ship?
5. Is all certification testing complete prior to LEM stack?
6. Is major analysis substituting for test?
7. Could PERT + QSL* provide certification test statusing?
8. What off-limits tests are performed?
9. Which of the qual ground rules are not followed during the S/S testing?
10. Have all the multiple subsystem test requirements involving this subsystem been identified?

*Qual Status List